CHAPTER I

OPERATIONAL PROCEDURES

A. GENERAL

Within Fleet Weather Central/Joint Typhoon Warning Center (FWC/JTWC), the responsibility for the basic analyses of the various charts lies with Fleet Weather Central (FWC). Surface prognoses are also prepared by FWC. Fleet Numerical Weather Facility (FNWF), Monterey, California, furnishes Northern Hemispheric computer analyses, prognoses and tropical cyclone steering trajectories. Joint Typhoon Warning Center (JTWC) is responsible for meso-analysis, typhoon forecasts and warnings.

B. ANALYSES

1. FWC:

a. Types of contour (c) and/or steamline (s) charts with standard times:

(1) Surface; 0000Z, 0600Z, 1200Z and 1800Z (c).
(2) Gradient level (2000 to 3000 ft. above ground); 0000Z, 0600Z, 1200Z and 1800Z (s).
(3) 850mb; 0000Z and 1200Z (s).
(4) 700mb; 0000Z and 1200Z (s) & (c).
(5) 500mb; 0000Z and 1200Z (s) & (c).
(6) 300mb; 0000Z and 1200Z (c).
(7) 200mb; 0000Z and 1200Z (s).
(8) Sea Surface Temperature Chart; 5-day mean composite updated once daily.

b. Other analyses:

(1) Checkerboards or Stidd Diagram.
(2) Time Cross-Sections.
(3) Selected Upper Air Soundings.
(4) Arowagram for Guam.
(5) Nephanalyses.

2. JTWC:

a. Meso-analyses:

(1) Sectional surface charts; hourly and 3-hourly as required.
(2) Reconnaissance reports.
(3) 700mb; 0000Z and 1200Z, 10-meter interval analysis (c).
(4) 500mb; 0000Z and 1200Z, 20-meter interval analysis (c).
(5) Stidd Diagram for selected stations as required.

b. Satellite Data:

Facsimile cloud photographs were received by the FWC APT ground equipment from ESSA II and NIMBUS weather satellites. Also, nighttime infrared data was received from NIMBUS. These data were very useful for initial identification of the tropical cyclone and in determining its location and stage of development. In addition, tropical cyclone bulletins, which gave the location and coded discription of the disturbance, were received from the National Weather Satellite Center (NWSC).

c. Land Radar:

Land radar reports were used in conjunction with aircraft reports whenever possible. These reports included range and bearing of the eye from the reporting station, eye characteristics and occasionally the direction, speed and movement of the eye. A combination of attenuation, operator inexperience and the fact that the radar could see only the tops of distant storms made land radar reports obtained at long ranges often inaccurate. However, as the storms approached the radar stations, the accuracy usually improved markedly.

C. FORECAST AIDS:

1. Climatology

The following climatological publications are utilized:

a. Climatological Aid to Forecasting Typhoon Movement (1st Weather Wing).

b. Annual Typhoon Report, 1965 (covering years 1953-1965; FWC/JTWC).

c. Western Pacific Typhoon Tracks 1950-1959 (FWC/JTWC).

d. Far East Climatic Atlas (1st Weather Wing - February 1963).

e. Tropical Cyclones in the Western Pacific and China Sea Area (Royal Observatory, Hong Kong). This comprehensive publication covers 78 years of typhoon tracks.

2. Persistence

3. Computer Products:

During the 1966 typhoon season, the following computer products were utilized:

a. From FNWF:

(1) Steering trajectories or forecast positions for 6, 12, 18, 24, 36, 48 and 72 hours for tropical cyclones as requested by JTWC for reconnaissance fixes at 0300Z and 1500Z.

(a). Three trajectories are provided: 1. 1000mb steering, 2. 500mb steering and 3. 500mb modified steering. The 500mb modified steering is furnished to account for empirically determined weaknesses in the 500mb steering model. The program for the above is presented in "Computer Products Manual, Technical Note No. 21" by LCDR R. E. Hughes, at Fleet Numerical Weather Facility pages 3.26-1 through 3.26-3, dated July 1966. A steering trajectory for 700mb is expected to be available during the 1967 season.

(2) The following listed products are utilized when applicable:

(a) Surface isobaric analyses; 00Z and 12Z.

(b) 700mb, 500mb, 300mb, and 200mb contour analyses; 00Z and 12Z.

(c) Surface, 700mb, 500mb, 300mb, and 200mb 24, 36 and 48 hour prognoses.

(d) 500mb isotach analyses; 00Z and 12Z.

(e) 500mb 12 and 36 hour isotach prognoses.

b. From NMC, Suitland:

(1) NWP Barotropic prog positions for typhoons for 12, 24, 36, 48, 60 and 72 hours were received when, in the opinion of NWP, the Computer produced progs were reasonable.

4. Objective Methods:

During the 1966 typhoon season, the following individual objective methods were used by JTWC:

a. WANG - Using 700mb data.

b. AROWA - Using 700mb and/or 500mb data.

c. FAIRLESS - Using surface data.

d. TSE - Using 700mb data.

(1) This new method was used near the end of the typhoon season and the results compared favorably with other objective techniques. The initial steps in the calculations are similar to that of the AROWA method but the big factor in favor of the Tse method is the addition of the "over-all synoptic pattern which makes allowance for the stage of storm development, the size of the storm, and the interaction between storm's circulation and the basic current as well as the influence of the nearby storms or other significant disturbances." For further detail on the method the reader is referred to "A New Method for the Prediction of Typhoon Movement Using the 700mb Chart", by S.Y.W. Tse in the Quarterly Journal of the Royal Meteorological Society, Vol. 92, No. 392, pages 239 through 253, dated April 1966.

5. Coordination:

When a tropical cyclone for which warnings are being issued is north of 25N, Fuchu Air Force Weather Central transmits position forecasts twice daily to JTWC which are used for comparison and consideration prior to issuance of the JTWC warning. Coordination with other Air Force and Navy activities is on an "as required" basis depending upon the location of a particular tropical cyclone.

D. WARNINGS:

Warnings are filed and transmitted every six hours at synoptic times of 0000Z, 0600Z, 1200Z and 1800Z. In accordance with CINCPAC Instruction 3140.1G the message contains the present warning position of the tropical cyclone which is valid for the scheduled transmission time. Therefore, the 24 and 48 hour warning forecast positions are actually 30 and 54 hour forecasts from the last synoptic time.

The warning position of a tropical cyclone is actually a short range forecast from the last "best" position. The last "best" position is usually about 3 hours old based on land radar or reconnaissance fixes, 3 to 6 hours old based on surface synoptic reports, or 6 to 12 hours old based on upper air synoptic reports. It is for this reason that the 0600Z warnings, for example, may not agree with the position of the tropical cyclone as indicated by the 0600Z analysis. Amendments are issued when this difference is significant.

The numbering of tropical warnings run consecutively regardless of whether the cyclone is upgraded or downgraded from tropical depression, tropical storm or typhoon. If warnings are discontinued and the circulation regenerates, the new series of warnings are numbered consecutively from the number of the last warning of the previous series. Amendments and corrections which are issued as required are given the same numbers as the warning which they amend or correct.

All 24, 48 and 72 hour forecasts made when a tropical cyclone is of tropical storm or typhoon intensity are verified against the "best track" as determined in post-cyclone analysis.

The 1966 verification summary is contained in Chapter IV.

E. FORECASTING PROCEDURE:

In preparation for issuance of the initial warning on a tropical cyclone, a track based on climatology is developed. This track is prepared for a time interval of 4 or 5 days at the speed indicated by climatology. Next, the track is modified in accordance with the existing and forecast upper air pattern, after which the initial warning is prepared and issued.

The basic forecasting technique used throughout the 1966 season was a subjective modification of the numerical steering prediction. Modifications were based on climatology and subjective evaluations of meso-analyzed 700mb and 500mb charts.

If the steering forecast looked reasonable, it was then checked for consistency with climatology and past history. The upper air charts were checked for areas of maximum divergence, areas offering the least resistance to the forward motion of the storm and the 700mb height criteria of Wang. An AROWA grid computation was made on the 700mb chart for most forecasts. In addition, a FAIRLESS computation was made on the surface chart for most forecasts, especially in the early stages. A TSE computation was also made for the storms near the end of the season.

A subjective integration of all the factors listed above was then used to establish or modify the forecast track of the storm. Speed of movement was then forecast from history, climatology, and the steering forecast.